ICWL’05 Tutorial Workshop

WME: Web-based Mathematics Education

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The WME Concept

The WME Research Homepage.
An Idea Whose Time Has Come

- Mathematics teachers and students need help in many countries.
- Availability and standardization of the Web and the Internet have grown and evolved sufficiently.
- Maturing technologies: MathML, ECMAScript, DOM, SVG, XML, CSS, Web Services, ...
- Symbolic and numerical computation systems, have matured and become Internet Accessible.
- Decreasing cost and increasing speed of WAN, LAN, and wireless networking.
- Schools in many places have begun to deploy Internet/Web in classrooms.
Web Helps Math Edu

The Web offers helpful materials for Mathematics teaching/learning.

- The Ohio Resource Center for Mathematics, Science, and Reading provides online resources for mathematics education.
- Mathematics section of the US Department of Education site.
- The National Science Foundation’s Math Is Power.
- The IES sponsored Education Resources Information Center, an extensive literature database.
- The Eisenhower National Clearinghouse for Mathematics and Science Education (ENC) links to lesson plans and activities.
- The NCTM Illuminations Project supplies applets for hands-on
learning.

- The PBS *Mathline* site.

- The National Library of Virtual Manipulatives for Interactive Mathematics (applets)

- Mathforum at Drexel University provides *Problem of the Week* and *Mathforum Math Library* among other useful materials.

- Other efforts: Internet4Classrooms, WIMS, Livemath, Mathwright, geometry.net, WebMathematica, Calc101, AcitveMath, Maple, and MathWeb.

- Also e-learning and e-education support infrastructure systems such as WebCT and Blackboard.
The WME Integration

- Modules & Lessons
- Comp/Edu Services
- Interactions
- Assessment
- Manipulatives
- Research Info
- Q & A Support
- Remedial Lessons
WME is Different

- Classroom-ready TLPs and TMs rather than assortments of teacher enabling materials.
- Lessons are interactive, integral, self-contained, and interoperable.
- Lessons are built by experts, conform to curriculum standards, and can cover entire grade levels.
- A WME site can be easily deployed to different schools and configured for local use.
The Kimpton Site.
• WME integrates interesting facts, real-world motivations, manipulatives, assessment tools, and teacher-student interaction for effective teaching and learning of mathematics.

• Lesson pages and modules can easily be customized by individual teachers for different classes.

• Interactive control and management by the teacher during classroom delivery.

• WME pilot at Kimpton Middle (Stow Ohio) has demonstrated its practicality and popularity with teachers and students.
The WME Architecture

- Javascript
- DOM
- SVG Viewer
- Other Plugins
- Web Browser
- MeML Plugin
- WME Services
- Lesson
- Topic Module
- Pages
- Database
- Active Page Support
- WME Site
WME Components

- Interoperable *Manipulatives, Topic Lesson Pages* (TLPs) and *Topic Modules* (TMs)
- Assessment Support—assessment question database, test construction, grading, evaluation, and online tests.
- Client-side Support—regular browsers, javascript, SVG viewer, DOM, browser plug-in.
- Server-side Support—using active pages (PHP) and database (MySQL).
- Content-markup Support—MeML and Woodpecker
- WME Services—MathChat, MathBoard, MESP, MCP, and SOAP.
### Manipulatives

Roll count (the number of rolls you made): 0.

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**Equation, Probability, Statistics**
WME Model Site Structure

- homepage
  - grade 7
  - grade 8

Standards
- number & op
- geometry
- algebra

Topic Modules
- percents
- fractions
- proportions
- areas
- equations

TLPS
WME Model Site

Model Site

Download
Configure
Install
Localize

School Site
WME Model Site

- In-School customization—user accounts, grade levels, course listings, course sections.
- In-class customization—TM and TLP selection, management, page content modification, page questions management.
- In-page customization—manipulatives editing: including text, presentation, and functionality.
Page Customization Layers
Customizing Pages

• Classroom-ready lessons and modules can be modified by teachers to suit their particular needs and requirements.

• Adding questions, modifying test, changing parameters, and adjusting manipulatives are done through password controlled simple on-Web tools attached to each page.

• Customizations are per page, per teacher and per class.
Mathematics Chat and Bulletin Board

• MathChat encourages student participation in topic discussions
• MathChat simulates classroom teacher-student interactions.
• MathBoard encourages student-student interactions and generally facilitates communication among all in the class.
• Both must support Math input and display.
SVG-Based Manipulatives

- Scalable Vector Graphics is an emerging W3C standard.
- Compactly delivers interactive graphics to support authoring and running manipulatives.
- Geometry-aware manipulatives support constraint-preserving user operations.
Base = 4.70  Height = 2.16
Area of the Parallelogram = 10.14
Area of the Rectangle = 10.14
Assessment

- Test authoring, construction, and editing
- Online test taking
- Importing and exporting test questions
- Automatic grading and test data management
- Results evaluation and leads to interventions
Top 10 Advantages

10 *Accessibility*

9 *Compatibility and interoperability*

8 *Richness and variety*

7 *Integrated, dynamic, and classroom-ready*

6 *Multiple efficient communication modes*

5 *Concepts not steps*

4 *Educator support, convenience, and control*

3 *Real-world motivations*

2 *Practical and flexible*

1 *Interactive, hands-on and self-paced*
Research and Collaboration

- Research and development challenges arise in computing and in education.
- System architecture, component interoperability, portability, usability and customization.
- System interfaces, markup language design, protocols, manipulatives, and tools.
- Educational effectiveness, practicality, and teacher/student acceptance, in-class trials, and effects evaluation.
- A research team ought to involve computer scientists, mathematicians, mathematics education researchers, school teachers, and education evaluation experts.